
APPENDIX A: BIOLOGICAL AGENTS

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APPENDIX A: BIOLOGICAL AGENTS

A terrorist incident involving a biological agent has the potential to cause a widespread medical emergency. The most likely bioterrorist scenario is a covert incident—that is, the biological agent will be released without warning or claims of responsibility. Because many biological agents produce effects that initially appear to be normal flu symptoms, the true nature of an attack may go undetected for a while. In most cases, there probably will be no identifiable crime scene, no explosion, and no fire.

In this scenario, detection of a bioterrorism incident will occur as increasing numbers of infected people seek medical care, and alert medical personnel and public health practitioners recognize that an unusual event is happening and report it to their response partners. Thus, it is likely to be medical detection and diagnosis and the emergence of unusual patterns of illness that will trigger investigation into the possibility of a terrorist incident.

Meanwhile, the disease may spread well beyond the initial point of attack, either through contagion or through movement of the biological agent itself. (If a release is overt, the event may unfold more quickly, but serious health effects and public requests for information and treatment may still overwhelm the system.)

The nature of a biological incident will vary with the type of agent that is used, the manner of exposure, and the method that is used to deliver the agent:

- Not all diseases caused by biological agents are contagious, and those that are vary both in how they are transmitted and how easily they can be spread.
- The time it takes for symptoms to appear after exposure varies from almost immediate to days or weeks, depending on the agent and the disease.
- Effects of exposure range from somewhat debilitating to lethal.

These differences have important implications that will affect response planning, including treatment of mass casualties, appropriate treatment measures, measures to control the spread of disease, worker protections, decontamination measures, handling of mass fatalities, and other issues.

TYPES OF BIOLOGICAL AGENTS

There are two broad types of biological agents: pathogens and toxins.

PATHOGENS

Pathogens are disease-causing living organisms, also referred to as *live agents*. They have life cycles in which they grow, reproduce, age, and die. Pathogens usually depend on another living organism (a host) to survive and grow.

Pathogens fall into several major groups, which differ in how they grow and spread.

PATHOGEN GROUP	CHARACTERISTICS
Bacteria and mycoplasmas	<ul style="list-style-type: none">▪ Can be grown in a laboratory—bacteria easily, mycoplasmas more slowly.▪ Only some bacteria cause disease; all mycoplasmas do.▪ Both can be treated with antibiotics.
Rickettsiae	<ul style="list-style-type: none">▪ Behave similar to bacteria but cannot grow independently (they must grow inside other cells).▪ Can be treated with antibiotics.
Viruses	<ul style="list-style-type: none">▪ Depend totally on a host. They grow by infecting cells, usually killing them in the process.▪ There is only one general antiviral drug (ribavirin).▪ There are only a few antiviral drugs that are effective against specific viruses.
Yeasts and fungi	<ul style="list-style-type: none">▪ Grow by branching and spread using spores.▪ Some yeasts and fungi are sources of toxins.▪ Fungi can be treated with specific antibiotics called antimycotics.

TYPES OF BIOLOGICAL AGENTS (CONTINUED)

PATHOGENS (CONTINUED)

In general, pathogens share the following characteristics:

- **Ability to multiply.** Pathogens can multiply once they have been dispersed. Therefore a small number of microorganisms can cause 100 to 1,000 times as many casualties as the same quantity of a chemical agent.
- **Vulnerability to weather elements.** Pathogens are reduced in number by exposure to weather elements. Most begin to decay when exposed to wind, rain, and sunlight, although some bacterial agents produce spores that can form protective coats and survive longer.
- **Inhalation exposure.** Pathogens infect primarily through inhalation. They cannot penetrate unbroken skin, although some can enter the body through open wounds.

TOXINS

Toxins are poisons derived from plants, animals, or microorganisms (e.g., plants, shellfish, sponges, corals). They do not grow, reproduce, or die after they have been dispersed, and relatively few are suitable for use as weapons. Toxins are difficult, in most cases, to synthesize in the laboratory, so they continue to be obtained from the organisms that create them—usually in very small quantities. (An exception is ricin, which comes from the castor bean and is easy to prepare in large quantities.)

In general, toxins share the following characteristics:

- **Severity of effects:** Toxins produce effects similar to those caused by chemical agents. They can cause injury and/or death with very small doses.
- **Skin absorption:** In addition to exposure by inhalation and ingestion, toxins can penetrate unbroken skin.
- **Specificity:** Toxins may attack specific systems of the body. Examples:

TYPE OF TOXIN	ATTACKS
Neurotoxin	Nervous system
Nephrotoxin	Kidneys
Hepatotoxin	Liver
Enterotoxin	Digestive tract

- **Removal:** In many cases, if a victim survives exposure, the toxins can eventually be flushed out of the system. (However, cytotoxins actually kill cells, leaving serious chronic health effects.)
- **Limited treatment options:** Toxins cannot be effectively treated with antibiotics. Although specific antitoxins are available for certain conditions, no broad-spectrum antitoxins currently exist.

ROUTES OF EXPOSURE

There are three primary routes of exposure to biological agents: through the respiratory system (inhalation), through the skin and mucous membranes (contact), and through the digestive system (ingestion).

EXPOSURE ROUTE	DESCRIPTION
Inhalation	Aerosolized biological agents can be inhaled into the lungs. The body is most vulnerable to this route of exposure because of the large surface area of the lungs and the susceptibility of mucous membranes to infection. If the body is unable to destroy the pathogen in the lungs, it may carry it to the lymph system where it causes systemic infection.
Contact	<p>Skin penetration by pathogens occurs primarily through open sores or rashes. High relative humidity promotes skin penetration, and pathogens may survive much longer on mucous membranes than on the skin because of the moist environment. Toxins can penetrate unbroken skin.</p> <p>Symptoms usually take longer to appear after skin exposure than after inhalation or ingestion (however, the reverse is true of anthrax).</p>
Ingestion	<p>Biological agents can enter the digestive system in several ways:</p> <ul style="list-style-type: none">▪ In contaminated food or drinking water. Even non-inhalable aerosols can contaminate food supplies or drinking water over long distances.▪ By hand-mouth contact after touching contaminated surfaces.▪ By swallowing mucus that contains particles lodged in the nose and throat. <p>This route of entry is the easiest to control—through hygienic measures and control of food/water supplies—as long as the contaminated sources are known or suspected.</p>

BIOLOGICAL AGENTS OF POTENTIAL INTEREST

The Centers for Disease Control and Prevention (CDC) has developed a prioritized list of biological agents of potential interest. The list includes three categories, shown in the following table.

CATEGORIES	AGENTS (DISEASES)
<p>Category A: Organisms that pose a risk to national security because they:</p> <ul style="list-style-type: none"> ▪ Can be easily disseminated or transmitted person-to-person. ▪ Cause high mortality and subsequently have a major public health impact. ▪ Might cause public panic and social disruption. ▪ Require special action for public health preparedness. 	<p>Variola major (smallpox) <i>Bacillus anthracis</i> (anthrax) <i>Yersinia pestis</i> (plague) <i>Clostridium botulinum</i> toxin (botulism) <i>Francisella tularensis</i> (tularemia) Hemorrhagic fever (e.g., Ebola, Marburg, Lassa viruses)</p>
<p>Category B: New or emerging pathogens that:</p> <ul style="list-style-type: none"> ▪ Are moderately easy to disseminate. ▪ Cause moderate morbidity and low mortality. ▪ Require specific enhancements of CDC's diagnostic capacity and enhanced disease surveillance. 	<p><i>Coxiella burnetti</i> (Q fever) <i>Brucella</i> species (brucellosis) <i>Burkholderia mallei</i> (glanders) Alphaviruses: Venezuelan, eastern, and western equine encephalomyelitis Ricin toxin from <i>Ricinus communis</i> (castor beans) Epsilon toxin of <i>Clostridium perfringens</i> <i>Staphylococcus enterotoxin B</i></p> <p>Foodborne or Waterborne Category B Agents: <i>Salmonella</i> species (typhoid fever) <i>Shigella dysenteriae</i> (dysentery) <i>Escherichia coli</i> O157:H7 (E-coli) <i>Vibrio cholerae</i> (cholera) <i>Cryptosporidium parvum</i></p>
<p>Category C: Emerging pathogens that could be engineered for mass dissemination in the future because of their:</p> <ul style="list-style-type: none"> ▪ Availability. ▪ Ease of production and dissemination. ▪ Potential for high morbidity and mortality and major health impact. 	<p>Nipah virus Hantaviruses Tickborne hemorrhagic fever viruses Tickborne encephalitis viruses Yellow fever virus Multi-drug resistant <i>Mycobacterium tuberculosis</i></p>

BIOLOGICAL AGENTS OF POTENTIAL INTEREST (CONTINUED)

The Specific Biological Agents chart includes a few additional biological agents that, although not included in the CDC categories, are mentioned by other organizations.

METHODS OF DISSEMINATION

Biological agents as terrorist weapons may be disseminated through air, water, or food. One released, the diseases they cause may be spread by vectors, vehicles, and carriers.

DISSEMINATION THROUGH THE AIR

Any of the CDC's A-list of deadly biological agents could be disseminated through the air, using aerosols or sprays. Both aerosols and sprays are liquid droplets or dry particles suspended in air that are released into the air. The difference is in the size of the droplets/particles released by the device nozzle. Aerosols have droplets/particles small enough to remain suspended and be inhaled. Sprays have bigger droplets/particles which fall to the ground more quickly and are more likely to contaminate surfaces and be absorbed through the skin or ingested.

- **Potential dissemination devices:** Spray cans, commercial sprayers, aerosol generators, systems designed to distribute pesticides from air or ground (e.g., crop duster airplanes and truck sprayers), heating/ventilating/air conditioning (HVAC) systems, fans.

Anthrax spores have been enclosed in mail which, when opened, disperses the spores into the air. There is the potential for the mail delivery system itself to become a means of spread when other pieces of mail pass through contaminated equipment or come into contact with contaminated mail items.

- **Potential targets:** Highly populated areas, enclosed public spaces (e.g., shopping malls, office buildings, sports/entertainment arenas, mass transit), crops and livestock.
-

METHODS OF DISSEMINATION (CONTINUED)

▪ **Relevant factors:**

- Airborne biological agents have the potential for large-scale effects.
- When dispersed outdoors, much of the biological agent may blow away or evaporate before reaching the ground. Rate of dispersion and direction of travel will vary greatly depending on atmosphere and weather. Some viruses die rapidly in the dry higher layers of air and when exposed to sun. When an agent is dispersed indoors, uncertainties are fewer.
- Some agents are killed by the chemicals used to aerosolize. However, anthrax spores can be produced in a form that, when milled to a very fine powder, can be dispersed as an aerosol. It has been speculated that T2 mycotoxins can also be aerosolized.
- Delivery by explosive device is thought to be a less effective means of disseminating a biological agent into the air because heat and other blast effects would destroy most pathogens.

DISSEMINATION THROUGH THE WATER SUPPLY

- **Potential targets:** Municipal water supply, enclosed water supplies, bottled water processing plants.

- **Relevant factors:**

- Contaminating large municipal water supplies may be difficult because water purification and sterilization processes, which typically use chlorine or ozone, will kill most biological agents.
- Smaller targets (e.g., the water supply in a building) could be attacked by introducing an agent directly into the water tank.

DISSEMINATION THROUGH THE FOOD SUPPLY

Infection of a food supply (agriterrorism) is a serious concern.

- **Potential dissemination devices:** Aerosols, sprays, crop dusters, liquid additives.
- **Potential targets:** Food crops and livestock using aerosols and sprays; food processing plants (e.g., dairy industry, meatpacking); imported foods and food additives; restaurants.

For information on the use of biological agents to infect the food supply, see Appendix E: Agriterrorism.

VECTORS, VEHICLES, AND CARRIERS

Once released, some pathogens can be spread by vectors, vehicles, or carriers.

- **Vectors:** Infected animals or insects that serve as hosts to the organism may spread the disease. For example, the bubonic plague is carried by rat fleas that spread the disease when they bite. Insect-borne viruses also have the potential of being introduced by intentionally releasing infected insects (e.g., mosquitoes, fleas).
- **Vehicles:** Inanimate carriers (e.g., food and water) may spread disease.
- **Carriers:** Infected humans can transmit contagious diseases to other humans.

WHAT MAKES A BIOLOGICAL AGENT EFFECTIVE AS A WEAPON?

There are innumerable biological agents, but only a relative few are potentially useful as weapons of terrorism. The following characteristics of biological agents affect the potential usefulness of a specific biological agent as a terrorist weapon.

MEASURES OF EFFECTIVENESS

Measures of effectiveness include:

- **Infectivity:** The ease with which the microorganism establishes itself in a host species (i.e., the more infective an agent is, the fewer organisms required to cause disease). A measure of infectivity is Minimum Infective Dose (MID)—the minimum number of organisms that have to be ingested to cause the disease.
- **Virulence:** The relative severity of the disease produced by a pathogen.
- **Toxicity:** The relative severity of the illness or incapacitation produced by a toxin.
- **Lethality:** The ease with which an agent causes death in a susceptible population. A measure of lethality is Lethal Dose, 50 percent (LD₅₀)—the size of the infective dose for an individual that will kill half of all the people receiving it.
- **Transmissibility:** Contagiousness—the ease with which disease is transmitted by victims. (For example, *salmonella* causes typhoid fever which, although extremely debilitating, is difficult to spread, so it has low transmissibility.) Transmission may be:
 - **Direct** (through personal contact).
 - **Indirect** (through material contaminated by the infected person).
 - **Secondary** (through particles spread by coughing or sneezing).
- **Stability or persistence:** The ability of the microorganism to persist over time. Many biological agents live for only a short time outside the human body. Spore-forming agents (e.g., *anthrax*) are more persistent. A measure of stability is decay rate—the agent's susceptibility to temperature, relative humidity, atmospheric pollution, and sunlight. The lower the decay rate, the greater the stability of the agent.

WHAT MAKES A BIOLOGICAL AGENT EFFECTIVE AS A WEAPON? (CONTINUED)

MEASURES OF EFFECTIVENESS (CONTINUED)

- **Incubation period:** The time between exposure and appearance of symptoms.

OTHER PRACTICAL FACTORS

Other practical factors also affect the usefulness of an agent as a weapon. They include:

- **Reliability:** Ability to produce a certain effect consistently, at low doses, after a short and predictable incubation period.
- **Effectiveness:** Lack of natural immunity or resistance in the population; limited treatment available.
- **Ease of manufacture:** Ease of production (e.g., the ease with which large amounts can be cultured in a lab or obtained from original sources), stability when stored or transported, and ease of dissemination.
- **Self-defense:** The ability of terrorists to protect and treat themselves.

DETECTION, DIAGNOSIS, AND INVESTIGATION

How are terrorist incidents involving the release of biological agents detected, diagnosed, and investigated?

DETECTION

Live agents cannot be detected by the human senses. Because biological attacks are likely to be covert, detection may rely on diagnosis of disease symptoms. Usually the first indication of a biological attack is the **first observed casualty**—most often detected by local physicians who diagnose the disease and report it to local public health officials.

DIAGNOSIS

Attempts to reach an accurate diagnosis on clinical grounds alone may not be possible. Specialized diagnostic kits may provide field identification capabilities. However, these kits are limited in availability and are very expensive. For toxins, field monitors capable of rapid detection are not available. Provisional identification will require specialized laboratory analysis to establish definitive diagnosis.

DETECTION, DIAGNOSIS, AND INVESTIGATION (CONTINUED)**INVESTIGATION**

Even then, epidemiological investigation must be done to determine whether the symptoms are typical of a natural occurrence of the disease or a unique event. When an unusual pattern of victim cases causes authorities to suspect bioterrorism, research is carried out to identify the source, mode of transmission, cause, and who is at risk.

Definitive determination of an attack and identification of the agent depend on the combination of medical diagnosis, laboratory analysis, epidemiological investigation, and criminal investigation.

Considerable time may elapse after an attack before medical personnel are able to differentiate a biological attack from natural disease.

DETECTION, DIAGNOSIS, AND INVESTIGATION (CONTINUED)**ATTACK INDICATORS**

Clues indicating a possible attack are listed in the following table.

Clues Indicating Possible Bioterrorism Attack

- ☐ Large number of ill persons with similar symptoms
- ☐ Large number of unexplained disease, syndrome, or deaths
- ☐ Steady stream of ill people at health facilities
- ☐ Unusual illness in a population (e.g., unusual for the geographic area, or occurrence in a segment of the population not usually susceptible)
- ☐ Higher morbidity and mortality than expected with a common disease or syndrome
- ☐ Failure of a common disease to respond to usual therapy
- ☐ Single case of disease caused by an uncommon agent
- ☐ Multiple unusual or unexplained disease entities in the same patient without other explanation
- ☐ Disease with an unusual geographic or seasonal distribution
- ☐ Multiple atypical presentations of disease agents
- ☐ Similar genetic type among agents isolated from disparate sources
- ☐ Unusual, atypical, genetically engineered, or antiquated strain of agent
- ☐ A disease pattern that differs from a naturally occurring epidemic—e.g., unexplained increase in incidence, or increasing incidence within a short period (hours or days)
- ☐ Simultaneous clusters of similar illness in noncontiguous areas, domestic or foreign
- ☐ Atypical aerosol, food, or water transmission
- ☐ Unusually high prevalence of respiratory involvement in diseases that typically cause a non-pulmonary syndrome
- ☐ Casualty distribution aligned with wind direction; lower attack rates among those working indoors than those working outdoors
- ☐ Illness among people exposed to common ventilation systems but no illness in people not exposed to those systems
- ☐ Increased numbers of sick or dead animals, often of different species
- ☐ Deaths/illnesses among animals as well as humans
- ☐ Large numbers of rapidly fatal cases, with few recognizable signs and symptoms (i.e., from exposure to multiple lethal doses near the dissemination source)
- ☐ Witness to an attack; abandoned spraying devices; unusual/unscheduled spraying; attack threat or report of an attack

CONSEQUENCES/EFFECTS OF EXPOSURE

The consequences of exposure to biological agents depend on the type of agent, the degree of exposure, and many other factors.

SIGNS AND SYMPTOMS

Symptoms vary with the type of biological agent. They may include:

- **Febrile symptoms:** Fever, headache, confusion, blurred vision, brain swelling.
- **Respiratory symptoms:** Coughing, flu-like symptoms, shortness of breath.
- **Digestive and intestinal symptoms:** Vomiting, nausea, diarrhea.
- **Skin symptoms:** Rash, sores, pain, itching, discoloration, painful skin lesions.
- **Generalized symptoms:** General malaise, muscular weakness, fatigue, numbness, paralysis, chills, shock.
- **Death.**

See Specific Biological Agents for signs and symptoms associated with specific agents.

SEVERITY

Disease severity varies with the agent. Lethality usually depends on the dosage, how virulent the strain is, the availability of effective treatment, how soon treatment is begun, and other factors. Young children, the elderly, chronically ill patients, and those with compromised immunological systems are more susceptible than others because they have decreased resistance to the disease effects.

CONTAGIOUSNESS

A few, but not all, live agents are contagious. Those that are range from mildly contagious (e.g., Venezuelan equine encephalitis) to extremely contagious (e.g., plague, smallpox).

Local officials must be ready to deal with the potential impact of an infectious disease outbreak on worker safety, mass care, health care services, decontamination, disposal of the dead, and other aspects of disaster response.

Responding to a large-scale infectious disease outbreak may require the use of a variety of emergency public health measures, including quarantine, isolation, closing public places, seizing property, mandatory vaccination, travel restrictions, and disposal of the dead.

CONSEQUENCES/EFFECTS OF EXPOSURE (CONTINUED)

POTENTIAL FOR MASS CASUALTIES

A bioterrorist incident has the potential for large numbers of casualties. Some highly lethal agents (e.g., anthrax, plague, ebola, botulism, ricin) may produce mass fatalities. The number of victims may overwhelm medical resources and infrastructure. Contingency planning should address the potential for unusually high demand on health care and mortuary services.

PSYCHOLOGICAL EFFECTS

Psychological reaction of a civilian population to biological attack is likely to be severe, and there is the potential for public panic. Actions of the media may exacerbate the public response.

Local officials must be able to control rumor and disseminate factual risk information to manage the numbers of exposed and non-exposed casualties that go to medical facilities. Psychological support strategies should be considered as part of the response effort.

POTENTIAL LONG-TERM CONSEQUENCES

Recovery planning should address the potential for long-term effects of a biological event, including:

- Chronic physical or mental illness.
 - Delayed health effects (e.g., cancer, birth defects).
 - New infectious diseases becoming endemic.
 - Long-term impact on food supply.
-

TREATMENT

There are three main defensive responses to exposure to biological agents: prophylactic, antibiotic, and therapeutic.

PROPHYLAXIS

Prophylactic measures are means of preventing those who have been exposed from developing an infection. Examples of prophylactic measures include:

Barrier protection (e.g., use of protective suits or sealed buildings to prevent intake of contaminated air).

Sterilization and disinfection (using chemicals, heat, irradiation, filtration to kill pathogens or reduce their numbers to safe limits).

Public health hygiene and personal hygiene (e.g., soap and water).

Processing food to kill pathogens or inactivate toxins.

Vaccination to create immunity to the disease.

Decontamination requirements and procedures will vary with the specific type of biological agent. Environmental decontamination and/or patient decontamination may be required, depending on the nature of the agent. (See the Specific Biological Agents chart.)

ANTIBIOTICS, ANTIVIRALS, AND ANTITOXINS

In some cases, drugs can be used to kill the pathogens that cause the disease.

- **Antibiotics** are generally used against bacteria, *Rickettsiae*, mycoplasmas, and fungi. A number of broad-spectrum antibiotics (e.g., penicillin) are available. Effectiveness often depends on how soon after exposure the drugs are administered. Many pathogens have developed resistance to particular antibiotics.
- **Antiviral** drugs are used against viruses. The only broad-spectrum antiviral drug currently available is ribavirin. Other antiviral drugs are restricted to single virus families.
- **Antitoxins** are used against toxins. No broad-spectrum antitoxins currently exist. Specific antitoxins are available for certain conditions (e.g., botulinum antitoxin for botulism).

The Centers for Disease Control and Prevention (CDC), State department of health, and U.S. Public Health Service are available as sources of pharmaceuticals and other resources during a bioterrorist incident. If the CDC Office of Bioterrorism is notified during an incident, the National Pharmaceutical Stockpile program can be activated, and antidotes, vaccines, ventilators, and other supportive medical supplies can be sent to the area within 12 hours. **However, local communities may need to be self-sufficient for at least 24 hours after a bioterrorist incident.**

TREATMENT (CONTINUED)

THERAPEUTIC MEASURES

Therapeutic measures treat symptoms using such therapies as general supportive care, rehydration, use of painkillers and anti-inflammatory drugs, and stimulation of the immune system.

WORKER PROTECTION

In the event of a terrorist incident involving an infectious biological agent (e.g., smallpox or pneumonic plague), certain workers may be at risk of infection. These workers include:

- First responders (police, fire, EMS) who transport ill patients to medical facilities.
- Health care workers who care for patients.
- Laboratory personnel who handle clinical specimens.
- Health department staff who visit patients during outbreak assessment or control.

Because bioterrorism attacks may be covert, these workers may be unaware of the presence or nature of a biological agent. Therefore, workers need to use standard prophylactic precautions (disposable gloves and gown, immediate hand-washing, face shield) to protect themselves when in contact with broken or moist skin, blood, or body fluids. Protective gear must be changed between patients to prevent transmission.

After a biological agent is identified, additional precautions may be required, including mass prophylaxis. If preventive drug therapies are available, it may be appropriate to administer emergency prophylaxis to at-risk personnel.

Workers involved in containing and recovering biological dissemination devices must take appropriate protective measures. Guidelines exist for some devices and agents (e.g., envelopes filled with Anthrax spores). Incident commanders, in coordination with public health professionals, must evaluate the potential threat in consultation with local health and law enforcement resources.

TREATMENT (CONTINUED)

SPECIFIC BIOLOGICAL AGENTS

BACTERIA							
DISEASE/ AGENT	DISSEMI- NATION	TRANS- MISSION	INCUBATION OR SYMPTOM ONSET	TYPICAL EFFECTS	TREATMENT	LETHALITY	DECONTAMI- NATION
Anthrax (<i>Bacillus anthracis</i>)	Inhalation, cutaneous (skin), ingestion	No (except cutaneous)	1–6 days; Initial symptoms often followed by short improvement; shock and death 24–36 hours after severe symptoms.	Inhaled: Fever, chills, malaise, headache, myalgia, eye pain, hyperaesthesias, severe respiratory distress. Cutaneous: black sores	Early antibiotics often effective, especially for cutaneous. Usually not effective after inhalation symptoms appear.	Pulmonary: 100% if untreated Skin: Low if treated	Sporicidal agent (iodine, chlorine)
Botulism [See Toxins]							
Brucellosis (<i>Brucella melitensis</i>)	Aerosol	No (except open skin lesions)	Variable (1 wk to several months); typically 3–4 wks.	Fever, chills, sweating, malaise, headache, myalgia, eye pain, weakness, fatigue; sometimes cough	Antibiotics	Low. Untreated disease can persist months or years.	Bacteriocidal solutions on contaminated surfaces; precautions with secretions
Cholera (<i>Vibrio cholera</i>)	Ingestion and aerosol	Rare	12–72 hrs	Sudden-onset diarrhea, cramps, vomiting, headache.	Antibiotics, fluids, electrolyte replacement	Low with treatment	Bacteriocidal solutions; enteric precautions; hand-washing
Plague (<i>Yersinia pestis</i>)	Aerosol; vectors: fleas on infected rats	High	1–3 days for pneumonic, 2–10 for bubonic	Brain inflammation, high fever, chills, headache, rash, hypotension, pulmonary syndrome, tender lymph nodes (bubonic)	Early antibiotics are effective	High if untreated	Precautions with secretions; heat, disinfectants, exposure to sunlight
Tularemia (<i>Francisella tularensis</i>)	Aerosol (highly infective)	No	1–10 days	Sore throat, pulmonary syndrome, rash, fever, chills, malaise, weight loss, non-productive cough	Antibiotics very effective	Moderate if untreated	Precautions with secretions; heat and disinfectants

Others:

Gas gangrene: Bacteria (*Clostridium perfringens*)
 Melioidosis: Bacteria (*Burkholderia pseudomallei*)—tropical disease carried by rats
 Typhoid fever: Bacteria (*Salmonella typhi*)—spread mainly through contaminated food and water
 Shigellosis (dysentery): Bacteria (*Shigella dysenteriae*)—highly infective, spread through contaminated
 water and food, rarely fatal to healthy young adults

TREATMENT (CONTINUED)

SPECIFIC BIOLOGICAL AGENTS (CONTINUED)

RICKETTSIA							
DISEASE/ AGENT	DISSEMI- NATION	TRANS- MISSION	INCUBATION OR SYMPTOM ONSET	EFFECTS	TREATMENT	LETHALITY	DECONTAMI- NATION
Q fever (<i>Coxiella burnetii</i>)	Ingestion and aerosol	Rare	14–16 days	Fever, chills, malaise, headache, myalgia, eye pain, hyperaesthesias, pulmonary syndrome, cough, chest pain. Illness lasts 2 days to 2 wks.	Antibiotics	Very low	Soap and water; weak hypochlorite solutions

Others:

Trench fever: *Rickettsia (Bartonella quintana)*

Typhus: *Rickettsia (Rickettsia prowasecki)*

Rocky Mountain spotted fever: *Rickettsia (Rickettsia rickettsii)*

TREATMENT (CONTINUED)

SPECIFIC BIOLOGICAL AGENTS (CONTINUED)

VIRUSES							
DISEASE/ AGENT	DISSEMI- NATION	TRANS- MISSION	INCUBATION OR SYMPTOM ONSET	COMMON EFFECTS	TREATMENT	LETHALITY	DECONTAMI- NATION
Smallpox (variola virus)	Aerosol	High (upon appearance of rash)	10–12 days	Fever, hypotension, rash	Ribavirin; prophylaxis; vaccine within 3 days of exposure	Low	Quarantine; airborne precautions
Venezuelan Equine Encephalitis (VEE)	Aerosol and infected vectors	Low (infectious for 72 hrs)	1–6 days	Sudden onset malaise, fever, rigors, severe headache, eye pain, Nausea, vomiting, cough, sore throat, diarrhea may follow.	Supportive only Vaccine available	Low	Blood and body fluid precautions; destroy virus with heat and disinfectants.
Viral Hemorrhagic fevers (VHF): Ebola, Lassa, Marburg, Hanta, Rift Valley, Dengue, Yellow fever, others	Contact and aerosol	Moderate	4–16 days	Fever, easy bleeding, edema, malaise, headache, vomiting, diarrhea, jaundice, shock, sore throat, rash	Intensive supportive care; antiviral drugs (ribavirin) or plasma for some; isolation; barrier procedures	Moderate to high	Hypochlorite or phenolic disinfectants; contact precautions; additional precautions if massive bleeding

Others:
 Viral encephalitis (Eastern equine encephalitis [EEEV], Japanese encephalitis virus, Western equine encephalitis)
 Tick-borne encephalitis (Far Eastern, European)

TREATMENT (CONTINUED)

SPECIFIC BIOLOGICAL AGENTS (CONTINUED)

TOXINS							
TOXIN/ SOURCE	TARGET	DISSEMI- NATION	TIME FROM EXPOSURE TO EFFECTS	EFFECTS	TREATMENT	LETHALITY (LD ₅₀ I.V. IN MICE, UG/KG)	DECONTAMI- NATION
Anatoxin A (from algae)	Nerve		Almost immediate	Similar to chemical nerve agent		170-250	
Batrachotoxin (from S. American tree frog)	Nerve		Usually within 1 hour	Numbness, loss of coordination, headache, irregular heartbeat, respiratory paralysis		0.1-2	
Botulinum toxin (from bacterium)	Nerve	Ingestion and aerosol	Hours to days	Flaccid paralysis, weakness, dizziness, dry mouth and throat, sore throat, pulmonary syndrome, blurred vision, respiratory failure, rapid death	Antitoxin, ventilatory assistance	High (.0003)	Hypochlorite and/or soap and water
T-2 Myco- toxins (from fungi)	Inhibits protein synthesis	Ingestion, skin contact, aerosol	2-4 hours	Pain and damage to exposed skin; respiratory effects and chest pain from inhalation. Severe poisoning: prostration, weakness, ataxia, collapse, shock, death.	No specific antidote. Superactivated charcoal if swallowed.	Moderate	Soap and water; saline eye irrigation; sodium hydroxide and sodium hypochlorite to detoxify. Very stable, even in high heat
Ricin (from castor bean plant, which is available in quantity)	Liver and bone marrow	Ingestion and aerosol	1-12 hours or more	Vomiting, nausea, diarrhea, cramps, bloody nose, fever, pulmonary edema 18-24 hrs after inhalation; severe respiratory distress and death in 36-72 hrs.	Treatment of pulmonary edema; gastric decontamination if ingested	High (0.1-3.7)	Skin: Weak hypochlorite solutions and/or soap and water

TREATMENT (CONTINUED)

SPECIFIC BIOLOGICAL AGENTS (CONTINUED)

TOXINS (CONTINUED)							
TOXIN/ SOURCE	TARGET	DISSEMI- NATION	TIME FROM EXPOSURE TO EFFECTS	EFFECTS	TREATMENT	LETHALITY (LD ₅₀ I.V. IN MICE, UG/KG)	DECONTAMI- NATION
Saxitoxin (from shellfish parasite)	Nerve	Ingestion and aerosol	Usually within 1 hour; may be longer depending on dose and individual	Tingling/numbness, weakness, limp paralysis; rapid death (2- 12 hrs after exposure).	Standard poisoning management, intubation, mechanical respiratory support. Specific antitoxin therapy successful in animals but untested in humans	8 Those who survive 12-24 hrs usually recover.	Hypochlorite and/or soap and water
Microcystin (from algae)	Liver		Usually within 1 hour	Shock, liver enlargement, stupor		25-200	
Palytoxin (from soft coral)	Nerve		Almost immediate	Muscle contractions, irregular heartbeat, rigid paralysis		.45	
Staphylococcal Enterotoxin B (from bacterium)	Digestive tract, lungs	Ingestion and aerosol	Usually within 1 hour; may be 3-12 hours	Sudden onset of fever, chills, headache, nausea, muscle aches, pulmonary syndrome; vomiting and diarrhea if ingested	Supportive care; ventilation for very severe cases; fluid management	< 1%; Higher exposure can lead to septic shock and death.	Hypochlorite and/or soap and water; destruction of contaminated food
Scorpion venoms and toxins	Nerve		12 hours	Irregular heartbeat, rapid breathing, vomiting, tearing, sweating, salivation			
Tetanus toxin (from bacterium)	Nerve		Up to 12 hours	Muscle spasms, lockjaw, rigid paralysis		0.001	
Tetrodotoxin (from Japanese puffer fish)	Nerve		Almost immediate	Vomiting, tingling, numbness, loss of muscle control and voice		8-9	